UNIVERSITY OF Minnesota

COLLEGE OF BIOLOGICAL SCIENCES
DEPARTMENT OF BIOCHEMISTRY • ST. PAUL, MINNESOTA 55101

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Dr. David Goldman
Physiological Sciences
Naval Medical Res. Institute
Bethesda, Maryland 20014

Dear Dr. Goldman:

During our recent conversation you indicated that you had sent us a section on "injuries" but the only thing we can find is the one I am enclosing and there seems to be quite a bit of duplication with the report that STAT [redacted] has written. Would you please go over this section and let us know if this is the most recent copy of your section. The reason I question this is there has been some mix up in my mail and it has been going to the Biochemistry Department on the Minneapolis Campus (which is Medical Sciences) rather than to the Biochemistry Department on the St. Paul Campus.

Best regards,

E. Orin Halvorson
Professor

EOH:jr
Enclosure
STAT cc: [redacted]

PROBLEMS RELATING TO INJURY AND THE EFFECTS OF ENVIRONMENTAL STRESS.

Man is still in the process of learning to live with machines. Whether his rate of learning is keeping up with the rate at which machines develop is perhaps questionable. In any case, he must try his best lest the machines overwhelm him. Furthermore, modern transportation exposes people not only to close contact with machines, but subjects them to an ever increasing variety of environmental conditions at a more rapid pace than ever before. One day a man may be in a temperate climate living a routine life and the next he may be in a hot, humid climate working, say, with jet aircraft or he may find himself in the artificial and perilous position of a crew member of a deep submergence vehicle in the ocean.

History and statistics suggest that while death and disability from disease is gradually being brought under control in military situations, it is doubtful if the same is true for injury and disability related directly to high-energy machines and unusual environments. Certainly any device containing large concentrations of energy is a potential weapon and a definite hazard. A list of such devices would be very long and would certainly include internal combustion engines, jet engines, atomic devices and electromagnetic and acoustic power generators. Vehicles containing some of these may also provide a complex interaction of several such sources, for example railroad trains, aircraft, trucks, tanks, ships, submarines and spacecraft.

Along with physical forces generated by high-energy devices, there may be exotic substances, some toxic, as well as sharp changes in ambient pressure, temperature and humidity. While all of these problems are important to society in general, they are particularly important to the Armed Forces because of the much more intensive use made of these high-energy devices and the much higher costs and risks associated with them and their operation. The design and construction of machines and vehicles must take into account the physiological tolerance limits of their operators and of the maintenance people with regard to the environmental forces. This involves a rather detailed knowledge of many aspects of human biology. In addition, the behavioral and social sciences become heavily involved when one includes the problems of effective use of these machines, particularly under the conditions of stress. For example, modern highspeed aircraft not only expose men to low ambient pressure, cold, intense noise and vibration, and even radiation, but the complexity of operating these aircraft makes great demands on behavioral capacity.

The problems become exceedingly complex; for example, the preparation of vehicles, weapons systems and procedures for their use often requires elaborate considerations of cost and time on the one hand and relative effectiveness and risk on the other. This type of analysis is particularly difficult to apply in situations where key information, in this case relating to biology, is missing. Research problems are not necessarily solved on schedule and important unpredicted results

are sometimes obtained. Furthermore, while fruitful applications of research may take years to develop in the physical science, they may take a great deal longer in the biomedical areas, if only because the situation is so much more complex.

Necessary biological information is obtained not only from the current state of knowledge, but also from special studies directed toward particular situations as they develop. Progress in the accumulation of biological knowledge in general is more or less continuous but spurts of applied research are undertaken in response to immediate problems. Even in applied research however, the time required to obtain information of direct value and to apply it may be very long. This is particularly true since basic research results are not necessarily obtained in useful form and much applied research may then be needed to provide relevant numerical information for specific situations.

It should thus be clear that the application of biology to problems of National Defense requires a strong research capability. Such a capability must extend well into basic research areas on the one hand and into applied studies on the other. Of course it is understood that we are referring here particularly to the areas involving the physiology, biochemistry, etc. of human beings. However, the problem is, of course, much broader, extending as it does into the areas of disease susceptibility, psychological stress, etc. Considerable effort has been spent in studying performance activities of operators of highly complex machines. Beyond the purely behavioral aspects of this, there is good reason to believe that careful studies of

sensory mechanisms would provide an important contribution not only for current systems but for the more advanced systems which the future will surely bring. A thoroughly adequate research program includes not only suitable facilities of which there appear to be many, but also a sufficient number of skilled scientists of which there are perhaps not a sufficient number. Beyond this, there is a great need for effective communication between the biologists who provide the information and the engineers and operations people who consume it. This problem of communication is a serious one partly because of the widely different backgrounds and attitudes of the two groups and partly because of the problem of physical location, since the scientist tends to stick to the laboratory, the design engineer to the drafting room, and the operations man to the field. Clearly, a major aspect is that of the need for mutual education and confidence. It is almost essential that there be people available who have some knowledge of both sides.

There is concern on the part of the panel that a number of these problem areas are not being adequately studied - as evidenced, for example, from current Viet Nam operations. While these inadequacies arise partly from the difficulty of predicting exactly where the next set of urgent problems will arise, they may involve even more importantly the lack of an adequate resource capability. In particular, the funding of applied research tends to attach itself to urgent problems, but at the last minute and on a short term basis only.

For example, studies on the effects of hot and humid environments tend to be dropped as soon as the emergency ceases, thereby weakening seriously a capability which may then have to be reconstructed for the next occasion.

The above comments should not be taken to imply that present activities are completely inadequate. There is strong support throughout the country for basic research in many biomedical areas and there are also a number of Government laboratories both in and out of the Armed Forces whose work has been essentially in both obtaining and applying the research material. However, there are areas in which environmental problems have not been as carefully studied as they should be and the effort needed for effective communication among biologists, engineers and design makers is still unnecessarily great. In the study of injury related to machinery and unusual environmental stresses, much has been done and much will continue to be done. However, the rapid increase in the overall rate of technological development offers the possibility of straining our resources for meeting emergencies. For example, many biomedical problems which have arisen out of the discovery of nuclear fission and its technological applications are still very far from being solved after 20 years. Problems now becoming important in the areas of deep sea submergence will require a much more extensive effort than is now being made. How soon further problems of comparable difficulty will arise is unpredictable and the panel feels strongly that every effort should be made to avoid being caught short.

7 April 1967 D. E. GOLDMAN